§19. Shot Summary of Neutral Beam Injection in LHD Experiment

Tsumori, K., Takeiri, Y., Kaneko, O., Osakabe, M., Oka, Y., Asano, E., Kawamoto, T., Akiyama R.

Experiments with neutral beam injection (NBI) started in large helical device (LHD) since October of 1998. The large helical device consists of two helical coils to form a static magnetic field to confine high temperature plasma. Two neutral beam lines are installed to LHD. The beams axes are set tangential to poloidal axis of the device. In order to avoid distortion of magnetic field caused by plasma current, one of the beam lines is arranged to a direction of co-injection and another is arranged to counter-injection.

The beam lines are characterized by equipping negative ion sources to increase the beam energy more than 100 keV. Two ion sources are installed to each beam line. Research and developments of those sources has been done for these ion sources, and characteristics of the sources are described in elsewhere 1), 2).

Port-through power P_{port} can be expressed as a product of some coefficient and electric power applied for beam acceleration $V_{beam} \cdot I_{acc}$. One can express the port-through power by following equation.

$$P_{port} = \{ \eta_{acc} \cdot \eta_{n} \cdot (1-f_{geom}) \cdot (1-\eta_{ri}) \} \cdot V_{beam} \cdot I_{acc}$$

where

$$V_{beam} = V_{ext} + V_{acc}$$

In equations above, η_{acc}, η_{n}, f_{geom} and η_{ri} are acceleration efficiency, neutralization efficiency, geometrical loss factor and re-ionization efficiency, respectively. The acceleration efficiency is defined as a ratio of H^- current to acceleration current just after accelerator. Voltage applied to hydrogen negative ions (H^- ions) V_{beam} indicates sum of voltages applied to extraction and acceleration electrodes.

In the NBI experimental period, H^- current could not measured directly and measurement on re-ionization efficiency was not established at that time. In order to evaluate port-through power, a calorimetric measurement was applied by making use of armor plate at opposite wall to injection port. Detailed description is shown in this review 3).

Figure 1 shows port-through powers injected by NBI-BL1 and BL2 individually. Neutral beam injection has been done from Sept. of 1998 to Dec. of 1998. Port-through powers of about 2 MW were obtained from both of beam lines.

Figure 2 presents total port-through powers obtained by summing the powers from two beam lines at same times. Around shot number of 6200, a maximum power of 3.7 MW was injected into target plasma.

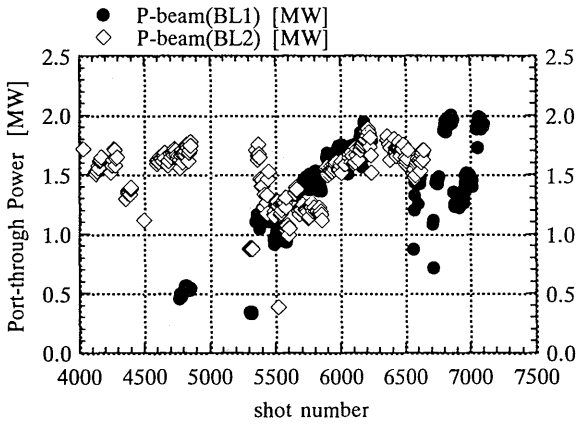

Fig. 1. Individual port-through powers injected by NBI beam lines numbered 1 (closed circles) and numbered 2 (open diamonds).

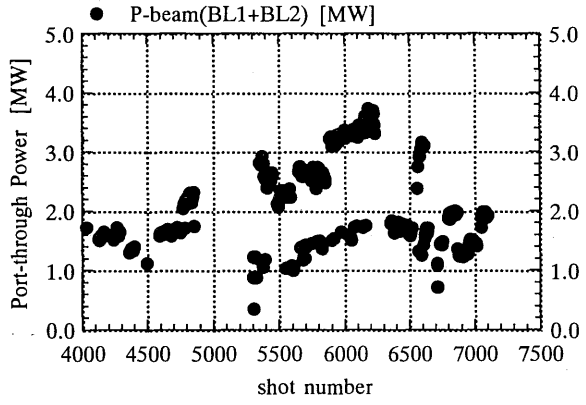

Fig. 2. The sum of port-through powers injected by NBI beam lines numbered 1 and numbered 2.

1) Tsumori, K., et. al, Ann.Rep.o NIFS, April 1997 – March (1998)
2) Takeiri, Y., et. al, Journal of Plasma and Fusion Res, vol. 74, No. 12 (1998) 1434
3) Osakabe, M., et. al, in this annual review.